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# FOREST PEST MANAGEMENT

BIOLOGICAL EVALUATION R2-92-02

PEST CONDITIONS AND POTENTIAL HAZARD TREES IN CAMPGROUNDS ALONG THE NORTH FORK SHOSHONE RIVER CORRIDOR, WAPITI DISTRICT, SHOSHONE NATIONAL FOREST

March 1992

United States Department of Agriculture

Forest Service

Forest Pest Management
Denver, Colorado

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March 1992


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EXPERIMENT STATION

## INTRODUCTION

At the request of Bob Boyle, Wapiti District Recreation Specialist, Shoshone National Forest, campgrounds along the North Fork Shoshone River corridor were visited on April 29-May 3, May 13-17, and September 9-13, 1991 to examine for pest condition and potential hazard trees. The objective of the examinations was to provide Forest Health Management input to the Vegetation Management Plans being prepared for these campgrounds. Specifically, the Forest and District requested information on the current hazard conditions of trees within these campgrounds and recommendations on how the general health of these trees could be improved.

## METHODS

The following recreation units were visited: Horsecreek Picnic Area (PA), Big Game Campground (CG), Wapiti CG, Elk Fork CG, Clearwater CG, Rex Hale CG, Blackwater Pond PA, Newton Creek CG, Eagle Creek CG, Sleeping Giant CG, and Threemile CG (Fig. 1). Trees in Pahaska CG, Sleeping Giant CG and Threemile CG were assessed using Angwin's (1990) procedures. Briefly, interior-unit and inter-unit plots were established at every 5th campsite beginning at a randomly selected site. All trees greater than 5 inches dbh and within 26.4 feet (0.05 acre) of plot centers were scored for species, size, and the presence of a variety of disorders (Appendix A), and rated for hazard (Appendix B). Trees were numbered consecutively clockwise from due North. Outside campground plots were established one half chain out from the campground edge. In contrast to intra- and inter-unit plots, outer campground plots were located every 2 chains along this perimeter and tally trees were selected using a 20 BA factor prism (Appendix C).

At the remaining campgrounds, plots were selected using the following modifications of Angwin's methods. Only intra-unit plots were used at Wapiti CG, Horse Creek CG, Elk Fork CG, Big Game CG and Newton Creek CG because these campgrounds were oriented such that outside campground plots could not be defined using Angwin's criteria and because a preliminary study at Wapiti CG using inter-unit plots showed no differences from intra-unit plots. At Clearwater CG, Rex Hale CG, and Blackwater Pond PA, plots were located every 2 chains along transects oriented parallel with the length of the site, because these units were so small that selection of every 5th campsite would result in less than 3 assessment sites.

FIGURE 1.

Locations of different recreation units assessed in this survey, page 3.

THIRTEENTH
STANDARD
PARALLEL
ABSAROKA
WASHAKIE
WILDERNESS
SLEEPING GIANT WINTER SPORTS AREA
THREE MILE
EAGLE CR
BLACKWATER POND
HEXTHALE
ELK FORK
CLEARWATER
WAPITI
WAPITI RANGER STATION
BIG GAME
HORSE CR
SHOSHONE
NEWTON CREEK
Historical Monument
Cloyster Mountain
Blackwater Natural Bridge
R 110 W
R 109 W
R 108 W
R 107 W
R 106 W
110°00'00"
109°52'30"
109°45'00"
Longitude west from Greenwich 109°37'30"

Figure 1

## RESULTS

The vegetation characteristics varied among recreation units, but generally units fell within one of four categories. I. JUNIPER - Horse Creek PA, II. COTTONWOOD/JUNIPER - Horse Creek PA, Big Game CG, Wapiti CG, Elk Fork CG, III. DOUGLAS-FIR - Clearwater CG, Rex Hale CG, Newton Creek CG, and IV. LODGEPOLE PINE - Eagle Creek CG, Sleeping Giant CG, and Pahaska CG. Other tree species included aspen, limber pine, Engelmann spruce, and subalpine fir. Tree density varied from 46 to 245 trees/acre (Table 1). Maps showing the general layout of the recreation units and general observations on the distribution of disorders within each are located in the Appendices D-M.

The major disorders present were a stem canker of cottonwood (cause unknown), a branch and crown dieback of Douglas-fir (cause unknown) and dwarf mistletoe on lodgepole pine (caused by Arceuthobium americanum). Dwarf mistletoe was found in all three campgrounds in which lodgepole pine occurred. The DM rating using the 6-class rating system developed by Hawksworth (1977) ranged from 0 to 3.9 (Table 2). Other disorders noted in this survey include broom rust of fir (caused by Melampsorella caryophyllacearum), of spruce (caused by Chrysomyxa arctostaphyli), and of juniper (caused by Gymnosporangium sp.), needle cast of lodgepole pine (Lophodermium sp.?), mountain pine beetle (Dendroctonus ponderosae) on lodgepole pine, Douglas-fir beetle (Dendroctonus pseudotsugae) on Douglas-fir, heart rot on juniper, Douglas-fir, and cottonwood (various causes), and Cooley spruce gall adelgid (Adelges cooleyi). The overall average hazard rating (using the tree hazard rating system described by Johnson (1981)) was 10.0, ranging from 6.0 to 16.4 (Table 2). Individual trees rated as high hazards (21 - 27) are listed in Table 3.

Characteristics of specific recreation units are described below.

### I. JUNIPER

**Horse Creek Picnic Area.** Vegetation is sparse (53 trees/acre) and composed almost entirely of juniper, with a few limber pine. Reproduction is sparse, consisting mainly of juniper. A thick grass covers most of this picnic area.

The average tree hazard rating is 3.2; most trees are not large enough to present a significant hazard.

TABLE 1.

Stand and plot descriptions, pages 6-8.

## STAND DESCRIPTION

| Unit | Species Composition | | | | | | Basal Area | | | | | | Trees Per Acre | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Three Mile C.G. | DF | AF | LPP | ES | JU | TOT | DF | AF | LPP | ES | JU | TOT | DF | AF | LPP | ES | JU | TOT |
| Interior | 1 | 11 | 84 | 4 | | --- | 8.6 | 17.9 | 47.3 | 7.5 | | 81.3 | 6.6 | 16.6 | 160 | 10 | | 193.2 |
| Inter-unit | 2 | 9 | 74 | 14 | | --- | 1.2 | 11.1 | 36.4 | 9.6 | | 58.3 | 3.3 | 13.3 | 116.1 | 20.1 | | 152.8 |
| Pooled | 1 | 10 | 79 | 9 | | --- | 4.9 | 14.6 | 41.8 | 8.5 | | 69.8 | 4.9 | 14.9 | 138.2 | 15.3 | | 173.3 |
| Outside | 9 | 3 | 79 | 9 | | --- | 14.2 | 2.9 | 62.7 | 1.1 | | 80.9 | 10.1 | 13.3 | 96.6 | 6.6 | | 126.6 |
| Eagle Creek C.G. | DF | AF | LPP | ES | JU | TOT | DF | AF | LPP | ES | JU | TOT | DF | AF | LPP | ES | JU | TOT |
| Pooled | 44 | 3 | 36 | 13 | 1 | --- | 70.7 | 4.5 | 32.9 | 18.6 | .5 | 127.5 | 65.4 | 4.6 | 53.6 | 19.1 | 1.8 | 144.5 |
| Horse Creek P.A. | DF | AF | LP | ES | JU | TOT | DF | AF | LP | ES | JU | TOT | DF | AF | LP | ES | JU | TOT |
| Pooled | | | 12 | | 88 | --- | | | 5.5 | | 14.7 | 20.2 | | | 6.6 | | | 46.6 |
| Rex Hale P.A. | DF | CW | LPP | ES | JU | TOT | DF | CW | LPP | ES | JU | TOT | DF | CW | LPP | ES | JU | TOT |
| Pooled | 57 | 26 | 4 | 7 | 4 | --- | 74.9 | 28.5 | 7.6 | 23.4 | 1.4 | 135.8 | 43.3 | 20 | 3.3 | 6.6 | 3.3 | 76.5 |

Table 1

## STAND DESCRIPTION (CONT.)

| Unit | Species Composition | | | | | | Basal Area | | | | | | Trees Per Acre | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Big Game T.C | DF | AF | CW | ES | JU | TOT | DF | AF | CW | ES | JU | TOT | DF | AF | CW | ES | JU | TOT |
| Pooled | | | 100 | | | --- | | | 65.3 | | | 65.3 | | | 65 | | | 65 |
| Newton Cr. T.C. | DF | AF | CW | QA | JU | TOT | DF | AF | CW | QA | JU | TOT | DF | AF | CW | QA | JU | TOT |
| Pooled | 90 | | | 2 | 8 | --- | 165.8 | | | 3.1 | 7.9 | 176.8 | 220 | | | 5.7 | 20 | 245.7 |
| Elk Fork C.G. | DF | LP | CW | ES | JU | TOT | DF | LP | CW | ES | JU | TOT | DF | LP | CW | ES | JU | TOT |
| Pooled | | 5 | 86 | | 9 | --- | | 8.9 | 204.1 | | 2.9 | | | 6.6 | 120 | | 13.3 | 139.9 |
| Blackwater P.A. | DF | AF | CW | ES | JU | TOT | DF | AF | CW | ES | JU | TOT | DF | AF | CW | ES | JU | TOT |
| Pooled | 100 | | | | | --- | 185.3 | | | | | 185.3 | 235 | | | | | 236 |
| Sleeping Giant | DF | AF | CW | ES | LP | TOT | DF | AF | CW | ES | LP | TOT | DF | AF | CW | ES | LP | TOT |
| Pooled | | 5 | 3 | 3 | 89 | --- | | 5.6 | 3.9 | 5.1 | 58.6 | 73.2 | | 5 | 2.5 | 2.5 | 87.5 | 97.5 |

Table 1

## STAND DESCRIPTION (CONT.)

| Unit | Species Composition | | | | | | Basal Area | | | | | | Trees Per Acre | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Clearwater P.A. | DF | CW | LPP | ES | JU | TOT | DF | CW | LPP | ES | JU | TOT | DF | CW | LPP | ES | JU | TOT |
| Pooled | 29 | 4 | 29 | | 38 | --- | 39.9 | 19.8 | 36.7 | | 13.1 | 109.5 | 29.7 | 5.2 | 30 | | 39.8 | 104.7 |
| Wapiti C.G. | DF | CW | LPP | ES | JU | TOT | DF | CW | LPP | ES | JU | TOT | DF | CW | LPP | ES | JU | TOT |
| Pooled | 6 | 76 | 4 | | 14 | --- | 4.1 | 79.1 | 2.8 | | 4.9 | 90.9 | 8.2 | 104 | 6.6 | | 18.7 | 137.5 |



Table 1

TABLE 2.

Tree hazard and dwarf mistletoe ratings
for recreation units surveyed during this survey,
pages 10-12.

## HAZARD AND DWARF MISTLETOES

| UNIT | Average Hazard Rating (0-9 Low, 10-20 Medium, 21-27 High) | | | | | | % Hazard Rating | | | Dwarf Mistletoes % Infection | | DMR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Three Mile C.G. | DF | AF | LPP | ES | JU | TOT | HIGH | MEDIUM | LOW | LPP | TOTAL | LPP | STAND |
| Pooled | 13 | 15 | 14.3 | 12 | | 13.5 | 14 | 32 | 54 | 78 | 61 | 2.7 | 1.7 |
| Horse Creek P.A. | DF | LP | LPP | ES | JU | TOT | HIGH | MEDIUM | LOW | LPP | TOTAL | LPP | STAND |
| Pooled | | 6 | | | 2.7 | 3.1 | | | 100 | 0 | 0 | 0 | 0 |
| Eagle Creek C.G. | DF | LP | LPP | ES | JU | TOT | HIGH | MEDIUM | LOW | LPP | TOTAL | LPP | STAND |
| Pooled | 6.4 | 6 | 14.1 | 6 | 2.7 | 9.8 | 9 | 14 | 77 | 24 | .08 | .03 | --- |
| Rex Hale C.G. | DF | LP | LPP | ES | JU | TOT | HIGH | MEDIUM | LOW | LPP | TOTAL | LPP | STAND |
| Pooled | 5.1 | | | | 3.3 | 8.7 | 13 | | 87 | 0 | 0 | 0 | 0 |
| Big Game T.C. | DF | CW | LPP | ES | JU | TOT | HIGH | MEDIUM | LOW | LPP | TOTAL | LPP | STAND |
| Pooled | | 12.5 | | | | 12.5 | 12 | 8 | 80 | 0 | 0 | 0 | 0 |

Table 2

## HAZARD AND DWARF MISTLETOES (CONT.)

| Unit | Average Hazard Rating (0-9 Low, 10-20 Medium, 21-27 High) | | | | | | % Hazard Rating | | | Dwarf Mistletoes % Infection | | DMR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Newton Cr. C.G. | DF | AF | LPP | QA | JU | TOT | HIGH | MEDIUM | LOW | LPP | TOTAL | LPP | STAND |
| Pooled | 6.1 | | | 27 | 2.7 | 7.0 | 4 | 6 | 90 | 0 | 0 | 0 | 0 |
| Elk Fork C.G. | DF | LP | LPP | CW | JU | TOT | HIGH | MEDIUM | LOW | LPP | TOTAL | LPP | STAND |
| Pooled | | 6 | | 18.9 | 3 | 16.4 | 26 | 42 | 31 | 0 | 0 | 0 | 0 |
| Blackwater P.A. | DF | LP | LPP | ES | JU | TOT | HIGH | MEDIUM | LOW | LPP | TOTAL | LPP | STAND |
| Pooled | 6 | | | | | 6.0 | | | 100 | 0 | 0 | 0 | 0 |
| Sleeping Giant | AF | LP | LPP | ES | JU | TOT | HIGH | MEDIUM | LOW | LPP | TOTAL | LPP | STAND |
| Pooled | 6 | 6 | 12.4 | 9 | | 11.9 | 9 | 39 | 52 | 91 | 79 | 3.9 | 3.1 |
| Clearwater P.A. | DF | LP | LPP | ES | JU | TOT | HIGH | MEDIUM | LOW | LPP | TOTAL | LPP | STAND |
| Pooled | 9.8 | 18.1 | | | 2.6 | 7.0 | | 3 | 7 | 0 | 0 | 0 | 0 |

Table 2

## HAZARD AND DWARF MISTLETOE (CONT.)

| UNIT | Average Hazard Rating (0-9 Low, 10-20 Medium, 21-27 High) | | | | | | % Hazard Rating | | | Dwarf Mistletoes % Infection | | DMR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wapiti C.G. | DF | AF | LPP | CW | JU | TOT | HIGH | MEDIUM | LOW | LPP | TOTAL | LPP | STAND |
| Pooled | | 5.3 | | 15.6 | 1.9 | 11.7 | 14 | 23 | 63 | 0 | 0 | 0 | 0 |



Table 2

TABLE 3

Individual trees rated as high hazard (hazard rating value equal to or greater than 21), using the rating system of Johnson (1981), in a survey of recreation sites along the North Fork of the Shoshone River in Shoshone National Forest, Wyoming. Unit number corresponds to the camp or picnic site number or a location marked on the corresponding recreation area maps in the Appendices D-M. At each unit, trees were numbered consecutively clockwise from due North. Trees within 26.4 feet of the plot center were examined. Plot centers were located midway between the fire pit and the picnic table.

| Site Name | Unit | Tree | Species | DBH | Comments |
|---|---|---|---|---|---|
| Big Game CG | 1 | 1 | cottonwood | 24.2 | |
| | 1 | 3 | cottonwood | 22.7 | |
| Wapiti CG | 1 | 9 | cottonwood | 11.2 | |
| | 6 | 1 | cottonwood | 12.7 | |
| | 6 | 2 | cottonwood | 11.3 | |
| | 10 | 22 | cottonwood | 13.1 | |
| | 16 | 9 | cottonwood | 11.4 | |
| | 16 | 11 | cottonwood | 14.5 | |
| | 27 | 1 | cottonwood | 11.0 | |
| | 27 | 2 | cottonwood | 16.0 | |
| | 32 | 3 | cottonwood | 16.8 | |
| Elk Fork CG | 6 | 3 | cottonwood | 16.6 | |
| | 6 | 5 | cottonwood | 13.2 | |
| | 6 | 9 | cottonwood | 32.3 | |
| | 11 | 1 | cottonwood | 26.0 | |
| | 11 | 2 | cottonwood | 34.0 | |
| Rex Hale CG | C | 1 | Douglas-fir | 15.3 | |
| Newton Creek CG | 11 | 4 | aspen | 10.2 | |
| | 16 | 3 | aspen | 9.1 | |
| Eagle Creek CG | 11 | 2 | lodgepole pine | 19.6 | |
| | 11 | 6 | lodgepole pine | 13.8 | dead |
| | 16 | 2 | lodgepole pine | 18.6 | dead |
| | 16 | 7 | lodgepole pine | 8.7 | |
| Sleeping Giant CG | 2 | 2 | Douglas-fir | 15.1 | dead |
| | 3 | 1 | lodgepole pine | 16.3 | |
| Three Mile CG | 4 | 1 | lodgepole pine | 5.4 | dead |
| | 9 | 8 | Douglas-fir | 9.6 | dead |
| | 14 | 5 | subalpine fir | 19.5 | |
| | 24 | 1 | lodgepole pine | 14.7 | |

II. COTTONWOOD/JUNIPER

**Wapiti Campground** - 41 sites. Cottonwood represents 75% of the trees assessed. Juniper, Douglas-fir and limber pine are also present, but much less abundant. In contrast, 86% of the reproduction (trees under 5 inches dbh) is composed of juniper; cottonwood accounts for only 12%, and Douglas-fir only 2%. Overstory density is moderate (137 trees/acre).

Differences between plots within and outside campsites are small and statistically insignificant, but some trends can be seen. Specifically, cottonwood is relatively less abundant in plots within campsites, but juniper is more abundant. Similarly, reproduction is much more abundant outside campsites. Trees above 5 inches dbh are equally abundant and the size class distribution of these trees is similar between both kinds of plots. The average dbh of the cottonwoods is 12.2 inches, and the dbh does not vary significantly between trees on plots within campsites and outside sites.

The overall average tree hazard rating is 11.7, with 9 of the 70 assessed trees ranked as high hazards. The major disorder in this campground is a canker disease of cottonwood. Twenty-four percent of all cottonwoods above 5 inches dbh are infected with this canker disease. Canker incidence inside the campsites is the same as outside campsites. However, severity of infection on individual trees may be higher in the former. The greatest proportion of infected trees occurs in the 10-14.9 size class. Furthermore, 21% (8/38) of the cottonwood trees that were bored are rotted. In most of these, little or no indication of the rot is visually apparent on the outside of the tree. Forty-six percent of the campsites have one or more trees that show structural failure. The most common type of structural failure is breakage of the main stem in the crown. A total of 32 trees within campsites are affected. Cankers are associated with breakage in 19% (6/32) of the trees. Decay is present at the site of failure and is the likely cause of failure in 11 of 32 trees.

Much of these data for Wapiti CG are applicable to Big Game Trailer Camp and Elk Fork CG.

**Big Game Tailer Camp** - 17 sites. Vegetation is composed of mature to overmature cottonwoods, with some scattered, small diameter limber pine and juniper. Stocking levels are low (65 trees/acre). The campground is open with a dense brush undergrowth. Regeneration levels are low.

Cottonwoods showing past crown failure are abundant and scattered throughout the campground, but relatively few of these are close to potential targets. Several trees had been previously topped. Overall average tree hazard rating is moderate (12.5). Of the 12 trees rated for hazard, 2 have the highest rating possible (27).

**Elk Fork Campground** - 13 sites. Vegetation is composed primarily of mature to overmature cottonwood, and a scattering of limber pine and juniper. Stocking levels are moderate (139 trees/acre). Reproduction is very scarce or lacking.

The overall average tree hazard rating is 16.7. Five of the 21 trees assessed rate as high hazard. Top failure (branches breaking off and falling out of the crown) is the most common type of tree disorder at this campground. Stem cankers are also common. Thirty-nine percent of the campsites have trees that showed evidence of past top failure. Seventy-eight percent of the failed trees have rot associated with the site of failure.

III. DOUGLAS-FIR

**Clearwater Picnic Area**. The Shoshone River marks the southern, western and eastern borders of the unit. The unit is bordered by mostly treeless pasture to the north. Within this picnic area, stocking is patchy, with low to moderate density (105 trees/acre). The western portion is composed mainly of juniper and Douglas-fir; reproduction is sparse or absent. The eastern portion is composed primarily of cottonwood, juniper and Douglas-fir; a moderate amount of cottonwood reproduction is also present. Overall, stocking is patchy with a low to moderate density.

Average tree hazard rating is 7.0, and none of the trees assessed rates as a high hazard. The crowns of 35% of the Douglas-fir trees in this campground show abnormal thinning of part of their crown (usually the top) or branch dieback or both. Douglas-fir trees outside the campground show a high incidence of this disorder, the cause of which is unknown. The intensity of this disorder increased as the summer progressed.

**Rex Hale Picnic Area**. This unit is sparsely stocked and reproduction is also sparse. The west end, where there are no picnic tables, primarily contains mature Douglas-fir. The east end is composed of small clusters of pure mature Douglas-fir and cottonwood.

Average hazard rating is 8.9, with one of the trees rated as a high hazard. Crowns of several Douglas-fir show abnormal thinning of part of the crown or branch dieback or both, similar to the condition found in Clearwater Campground. Several trees across the river opposite the campground have a similar appearance. Some of the large diameter cottonwoods have heartrot and a few others have been felled by beavers.

**Blackwater Pond Picnic Area.** Vegetation is composed of mature Douglas-fir at a relatively high density (235 trees/acre). Reproduction is sparse, composed of Douglas-fir and juniper.

Average hazard is 6, with all assessed trees rated low hazard. The picnic area is in good health. No significant disorders are noted.

**Newton Creek Campground** - 31 camp units. The dominant tree species at this campground is Douglas-fir, although juniper and cottonwood are also present. Stocking is moderate to heavy (245 trees/acre). Reproduction is moderate to lacking and clustered across the area.

Average tree hazard rating is 6.9, with 3 of the 82 trees assessed ranking as a high hazard. The major tree disorders noted in this campground are branch dieback, similar to that found in Clearwater and Rex Hale Campgrounds, and bark beetle mortality of Douglas-fir. Several trees showing the latter have been recently felled.

**Eagle Creek Campground** - 20 units. In the southwest half of this campground, lodgepole pine, spruce, subalpine fir and Douglas-fir mix with a few junipers and cottonwoods. The trees are mixed in height and diameter. Reproduction is abundant with Douglas-fir, lodgepole pine and Engelmann spruce the dominant species. The east half of this campground is composed of Douglas-fir, lodgepole pine and spruce. Reproduction in the eastern half of this campground is much less abundant than in the west half.

Average hazard rating is 9.8, with 4 of the 43 assessed trees ranking as high hazards. The primary tree disorders are dwarf mistletoe and bark beetles on lodgepole pine, broom rust and mortality (cause unknown) in spruce, and branch dieback and heartrot in Douglas-fir. Mistletoe distribution is limited and patchy, and this campground has an overall DM rating of less than 1.0.

## IV. LODGEPOLE PINE

**Sleeping Giant Campground** - 6 units. The dominant tree species is lodgepole pine. Stocking is moderate (98 trees/acre). Reproduction is moderately heavy, composed mainly of lodgepole pine.

Average hazard rating is 11.9, with 2 of the 23 trees assessed ranking as high hazards. The major tree disorders in this campground are lodgepole pine dwarf mistletoe on pine, pine stem rust, and broom rust of spruce. The mistletoe infected lodgepole pine trees are uniformly distributed throughout the campground. Basal and stem cankers from mechanical damage are abundant on these trees as well. Several of the lodgepole pine at the western edge are attacked by bark beetles. Spruce is moderately to heavily infected with spruce broom rust, and Cooley spruce gall adelgid is also present. Much of the lodgepole pine reproduction is infected with mistletoe.

**Three Mile Campground** - 30 units. Vegetation is primarily lodgepole pine, with some Douglas-fir, subalpine fir and Engelmann spruce. Overall, tree density is moderate. Interior plots are more dense than inter-unit plots or plots located outside the campground, but species composition does not vary among the different plot locations.

Average hazard rating is 13.5, with 5 of the 37 assessed trees in the high hazard category. The primary disorder in this campground is lodgepole pine dwarf mistletoe (DMR = 2.74), which is spread uniformly throughout this campground. DM ratings do not significantly differ between plots located inside and outside the campground. Some trees show physical wounds (e.g., axe wounds). Broom rust is present on spruce and mountain pine beetle is present on lodgepole pine.

## MANAGEMENT ALTERNATIVES

Many of the following management alternatives are adequately described by Angwin (1990).

1. **Do nothing.** Under this alternative, the number of cankered trees in Big Game CG, Wapiti CG, and Rex Hale CG will increase and the size of individual cankers on the main bole and branches will enlarge. As a result, top failure and stem breakage will become more frequent and the potential to harm people, vehicles or buildings resulting from failed trees will increase. Douglas-fir trees at Clearwater CG, Rex Hale CG and Newton Creek CG may continue to die. Dwarf mistletoe at Eagle Creek, Sleeping Giant and Pahaska CG will increase resulting eventually in tree death and trees becoming more susceptible to such associated stresses as mountain pine beetle.

2. **Reduce tree hazard potential.** High hazard trees noted in this survey (Table 3) should receive immediate attention. Remaining trees should be assessed and documented for hazard and corrective measures taken. An annual program should be initiated in which district personnel are trained to conduct hazard assessments. Hazard tree rating and management is described in Johnson (1981). In addition, the personnel of the Forest Health Management, Rapid City Service Center are available to assist the District in developing a campground tree hazard evaluation program.

3. **Implement dwarf mistletoe control.** Under this alternative, Pahaska CG, Sleeping Giant CG, and part of Eagle Creek CG would be managed to reduce dwarf mistletoe. Guidelines, which are presented in detail by Hawksworth and Johnson (1989), and FPM (1990a,b) include: a. Reduce probability of further disease buildup by pruning infected branches and removing infected trees, treating with ethephon, and encouraging non-host species; b. Reduce probability of disease spreading to uninfected or treated areas of the stand by creating buffer strips; c. Thin stand and prune infected branches to increase general health and life span of remaining trees and to reduce chance of attack by secondary insects and disease; and d. Closing campgrounds to enable recovery of vegetation in intensely infected areas.

4. **Revegetate sparsely stocked areas.** Under this alternative, a mix of tree species would be planted to enhance tree diversity and size structure of stands and ensure long term replacement trees for the current overstory. The revegetation process might be accelerated by using a tree spade to plant larger stock from the surrounding stands.

5. **Provide leaflets or display boards in campgrounds to explain to users what and why management practices are being pursued.** Campground hosts may also assist with the education of campers concerning vegetation management efforts. In addition, campers may also be encouraged to help in the revegetation efforts by watering the newly planted seedlings.

## MANAGEMENT RECOMMENDATIONS

**Big Game Campground.** High hazard trees and other large cottonwoods growing near campsites should be removed. Undergrowth should be managed to encourage regeneration. Juniper would be a possible alternative to cottonwood, because it grows well at Wapiti CG, which is very close to Big Game CG.

**Elk Fork Campground.** Remove high hazard trees, especially large cottonwoods. Manage residual vegetation so that the cottonwoods will be replaced by juniper and Douglas-fir.

**Clearwater Campground.** Remove high hazard trees, and encourage regeneration. The cause of branch dieback of Douglas-fir should be investigated. Many of the Douglas-fir in this campground are probably going to die. Dead trees should be removed as soon as possible.

**Horse Creek Picnic Area.** At some sites, the branches of juniper trees are very close to the fire pit. These branches should be pruned.

**Rex Hale Campground.** Remove high hazard trees. Plant seedlings in bare areas, and encourage regeneration as much as possible. Over time, remove large trees.

**Newton Creek and Eagle Creek Campgrounds.** The main management objective would be to enhance tree health by lowering average age of the stand. The stand should be opened up to encourage regeneration. At present, the existing Douglas-fir are producing a considerable number of cones, but the soil surface is too shaded to allow much new establishment. Reduce lodgepole pine as the budget permits. Remove mistletoe infected trees and encourage Douglas-fir to replace lodgepole pine. The overall health of the stand can be improved by cutting out larger Douglas-fir and opening the stand for regeneration. This can be done over a period of time.

**Three Mile Campground and Sleeping Giant Campground.** Species other than lodgepole pine should be encouraged to grow. Cut out infected trees over time, and encourage regeneration of species other than lodgepole pine. Planting of mistletoe-resistant species should be considered.

**Sites with mountain pine beetle or Douglas-fir beetle activity.** In the sites identified with beetle activity, a minimum preventative action should be removal in the fall of infested trees. This should reduce the beetle population and loss of additional trees. Entomologists should be consulted for more specific recommendations on other alternatives including use of preventative chemical insecticide applications, thinning prescriptions to reduce stand susceptibility, treatment of felled trees by mechanical or chemical methods to destroy beetle brood, and use of antiaggregative pheromones.

APPENDIX A. Field data sheet used to assess intra- and inter-unit campground plots.

APPENDIX B. Field form used to rate trees for hazard (developed by D.W. Johnson 1981).

APPENDIX C. Field data sheet used to assess outside-unit campground plots.

APPENDICES D-M. Diagrams of general layout of recreation units and general distribution of disorders observed in each unit. Circled letters and numbers correspond to plot locations. Circled x signifies inter-unit plots. Letters not circled correspond to the following: B = beetles, BR = broom rust, CR = comandra rust, D = dead, F = flagging, I = defoliation/dead branches, M = mistletoe, T = upper crown degradation/upper crown dying, and Cot = cottonwood, DF = Douglas-fir, LPP = lodgepole pine, Lim = limber pine, S = spruce, and F = fir.

# APPENDIX A

## INSIDE-CAMPGROUND SURVEY

Forest:_____ District:_____ Campground:_____
Date Of Inspection:_____ Evaluated By:_____
Unit No.:_____
Interior Plot:_____ Inter-Unit Plot: _____ Between Campsites:_____
Habitat Type:_____ Understory Vegetation:_____

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Tree No. | | | | | | | | | | |
| Species | | | | | | | | | | |
| DBH | | | | | | | | | | |
| Crown Ratio | | | | | | | | | | |
| DM Rating | | | | | | | | | | |
| Root Disease | | | | | | | | | | |
| Stem Decay | | | | | | | | | | |
| Internal Decay (Sound/Drill/Core) | | | | | | | | | | |
| Cankers | | | | | | | | | | |
| Rust | | | | | | | | | | |
| Human Damage | | | | | | | | | | |
| Defoliating Insects (% Defoliation) | | | | | | | | | | |
| Bark Beetles | | | | | | | | | | |
| Other Insects | | | | | | | | | | |
| Hazards | | | | | | | | | | |

Regeneration Plots (# trees of each spp. <5" DBH,
# trees or each spp. >2', <2' tall)

Plot 1. (Left)

Plot 2. (Right)

# TREE HAZARD EVALUATION

**FOREST:** _____ **DISTRICT:** _____ **SITE NAME:** _____

**DATE OF INSPECTION:** _____ **EVALUATED BY:** _____

**REVIEW AND COMMENTS BY:** _____
(District Ranger)

| | | | RISK VALUE | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1/ | UNIT NO. | | | | | | | | | | | | | | | | | | |
| | | MAP NO. | | | | | | | | | | | | | | | | | | |
| | | TREE NO. | | | | | | | | | | | | | | | | | | |
| | | D.B.H. (MINIMUM 7") | | | | | | | | | | | | | | | | | | |
| TREE SPECIES | 'A' | Pinyon, junipers, scrub oak | 1 | | | | | | | | | | | | | | | | | |
| | | ponderosa pine, 5-needle pines, Douglas-fir | 2 | | | | | | | | | | | | | | | | | |
| | | Spruce/fir, aspen, cottonwood, lodgepole pine | 3 | | | | | | | | | | | | | | | | | |
| POTENTIAL TARGET(S) | 'B' | trails (low use), signs, etc | 1 | | | | | | | | | | | | | | | | | |
| | | temporary structures, trails (heavy use) | 2 | | | | | | | | | | | | | | | | | |
| | | permanent structures, parked vehicles people | 3 | | | | | | | | | | | | | | | | | |
| DEFECT(S) PRESENT | 2/ 'C' | no visible defect | 0 | | | | | | | | | | | | | | | | | |
| | | slime flux, small mechanical injury | 1 | | | | | | | | | | | | | | | | | |
| | | limb defects, brooms, frost cracks, lightning scars, large mechanical wounds, forked trees, bole cankers | 2 | | | | | | | | | | | | | | | | | |
| | | exposed roots, bole cankers (decayed), dead top, conks, punky knots, butt rot, basal cavity, leaner (unnatural), root rot, dead trees | 3 | | | | | | | | | | | | | | | | | |
| RISK RATING | 3/ Ax | HIGH (21-27) | | | | | | | | | | | | | | | | | | |
| | Bx | MED (10-20) | | | | | | | | | | | | | | | | | | |
| | C | LOW (0-9) | | | | | | | | | | | | | | | | | | |
| INTERNAL INSPECTION | 4/ | increment borings (yr ) taken | | | | | | | | | | | | | | | | | | |
| | | inches sound wood | | | | | | | | | | | | | | | | | | |
| | | year next boring recommended | | | | | | | | | | | | | | | | | | |
| RECOMMENDED ACTION | | Fell | | | | | | | | | | | | | | | | | | |
| | | Top | | | | | | | | | | | | | | | | | | |
| | | Prune | | | | | | | | | | | | | | | | | | |
| | | Remove Target | | | | | | | | | | | | | | | | | | |
| | | Observe | | | | | | | | | | | | | | | | | | |
| | | None | | | | | | | | | | | | | | | | | | |
| | | Other | | | | | | | | | | | | | | | | | | |
| | | Date Corrective Action Taken | | | | | | | | | | | | | | | | | | |
| | | COMMENTS | | | | | | | | | | | | | | | | | | |

1/ Prepare map of hazard tree location on reverse side of form

2/ Any tree with a risk value of 1 or 2 may require increment boring, a value of 3 requires increment boring

3/ To determine Risk Rating (High, Medium, Low) for each tree evaluated, sum risk values (1, 2, & 3) under A, B, C (value not to exceed 3) and multiply sums A•B•C (i.e. Risk Rating cannot exceed 27).

4/ Tree Hazards Recognition and Reduction in Recreation Sites, Rocky Mtn. Tech. Rep. R2-1 (Revised 1981) See Figure 7.

# Appendix C

OUTSIDE-CAMPGROUND SURVEY

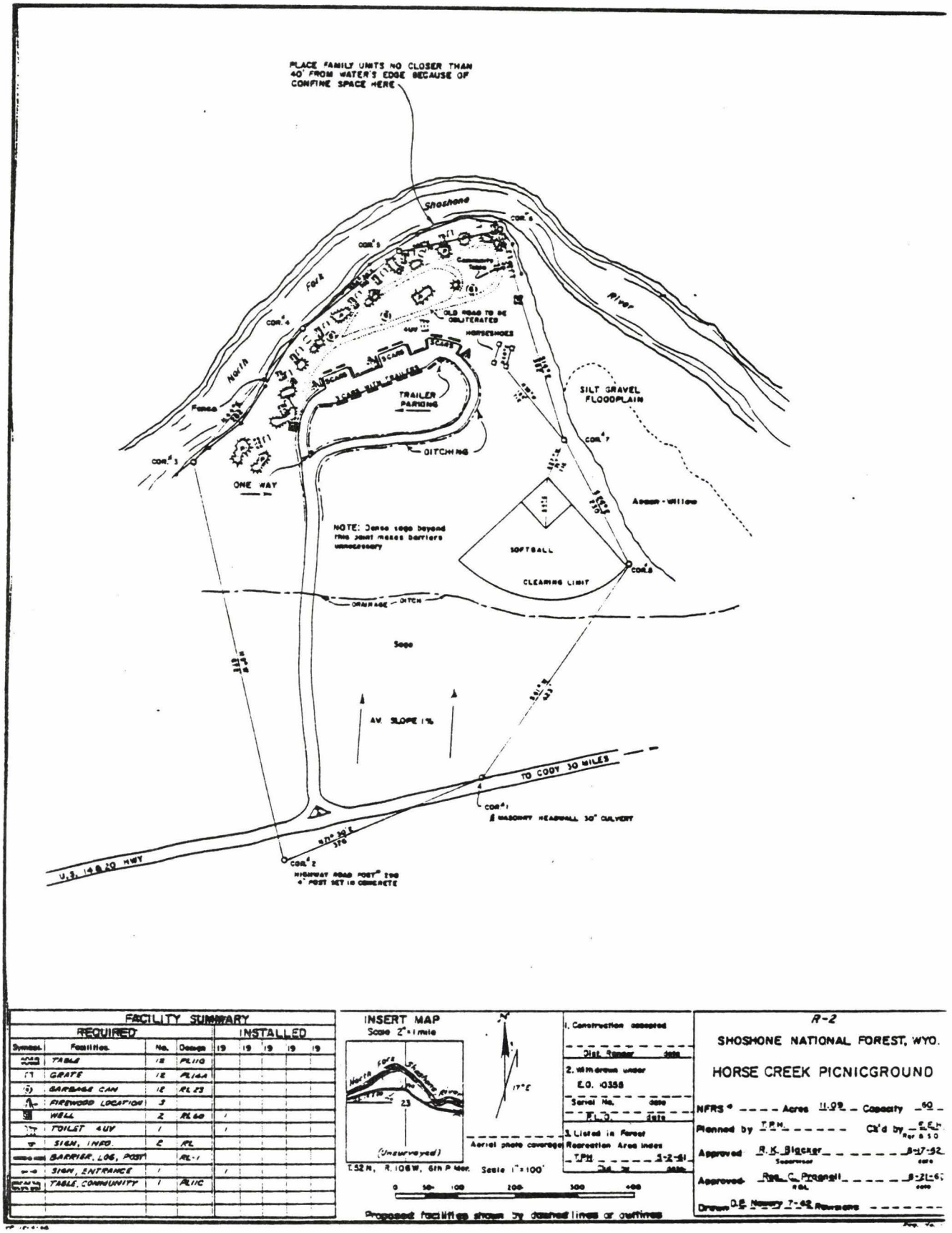
Forest:_____ District:_____ Campground:_____

Date Of Inspection:_____ Evaluated By:_____

Plot No.:_____ Slope:_____ Aspect:_____

Habitat Type:_____ Understory Vegetation:_____

| Tree No. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Species | | | | | | | | | | |
| DBH | | | | | | | | | | |
| Crown Ratio | | | | | | | | | | |
| DM Rating | | | | | | | | | | |
| Root Disease | | | | | | | | | | |
| Stem Decay | | | | | | | | | | |
| Internal Decay (Sound/Drill/Core) | | | | | | | | | | |
| Cankers | | | | | | | | | | |
| Rust | | | | | | | | | | |
| Defoliating Insects (% Defoliation) | | | | | | | | | | |
| Bark Beetles | | | | | | | | | | |
| Other Insects | | | | | | | | | | |
| Notes | | | | | | | | | | |




| FACILITY SUMMARY | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| REQUIRED | | | | INSTALLED | | | | | | |
| Symbol | Facilities | No. | Design | 19 | 19 | 19 | 19 | 19 | | |
| | TABLE | 12 | FL110 | | | | | | | |
| | GRATE | 12 | FL14A | | | | | | | |
| | GARBAGE CAN | 12 | FL23 | | | | | | | |
| | FIREWOOD LOCATION | 3 | | | | | | | | |
| | WELL | 2 | FL60 | 1 | | | | | | |
| | TOILET 4UV | 1 | | 1 | | | | | | |
| | SIGN, INFO. | 2 | FL | | | | | | | |
| | BARRIER, LOG, POST | | FL-1 | | | | | | | |
| | SIGN, ENTRANCE | 1 | | 1 | | | | | | |
| | TABLE, COMMUNITY | 1 | FL11C | | | | | | | |

INSERT MAP
Scale 2" = 1 mile




T.52N., R.106W., 6th P.Mer. Scale 1" = 100'

Aerial photo coverage

17°E

0 50 100 200 300 400

Proposed facilities shown by dashed lines or outlines

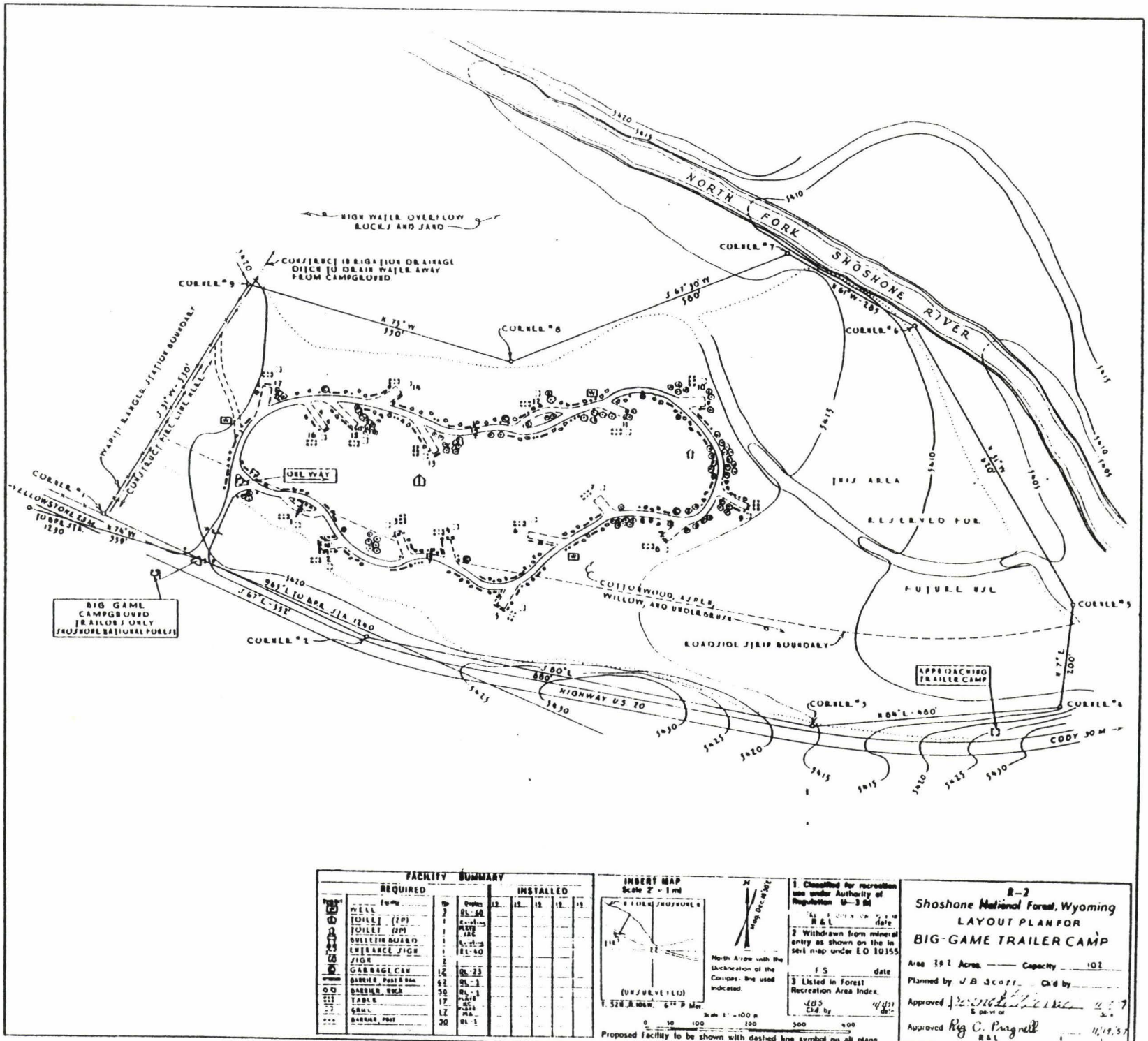
1. Construction accepted
Dist. Ranger date

2. Withdrawn under E.O. 10355
Serial No. date
F.L.D. date

3. Listed in Forest Recreation Area Index
T.P.M. 5-2-61
Init. date

R-2
SHOSHONE NATIONAL FOREST, WYO.
HORSE CREEK PICNICGROUND

NFRS # ____ Acres 11.09 Capacity 60
Planned by T.P.M. Ck'd by E.E.H. Apr 8 '52
Approved R.K. Blecker Supervisor 8-17-52 date
Approved Reg. C. Program Director R.O. 8-21-62 date
Drawn D.E. Newby 7-62 Revisions




**FACILITY SUMMARY**

| | Facility | REQUIRED Qty | REQUIRED Quality | INSTALLED 12 | 13 | 13 | 13 | 13 |
|---|---|---|---|---|---|---|---|---|
| Sanitation | WELL | 3 | QL-60 | | | | | |
| | TOILET (2P) | 1 | Existing | | | | | |
| | TOILET (4P) | 1 | WATER JAC | | | | | |
| Signs | BULLETIN BOARD | 1 | Existing | | | | | |
| | ENTRANCE SIGN | 1 | QL-60 | | | | | |
| | SIGN | 2 | | | | | | |
| Misc. | GARBAGE CAN | 12 | QL-23 | | | | | |
| | BARRIER, POST & RAIL | 62 | QL-3 | | | | | |
| | BARRIER, ROCK | 50 | QL-3 | | | | | |
| Furniture | TABLE | 17 | QL-PLATE | | | | | |
| | GRILL | 12 | QL-POST MA | | | | | |
| Roads | BARRIER, POST | 30 | QL-3 | | | | | |

**INSERT MAP**
Scale 2" = 1 mi

(UNSURVEYED)
T. 52N. R. 106W. 6TH P. Mer.

North Arrow with the Declination of the Compass line used indicated.

Scale 1" = 100 ft
0 50 100 200 300 400

Proposed facility to be shown with dashed line symbol on all plans

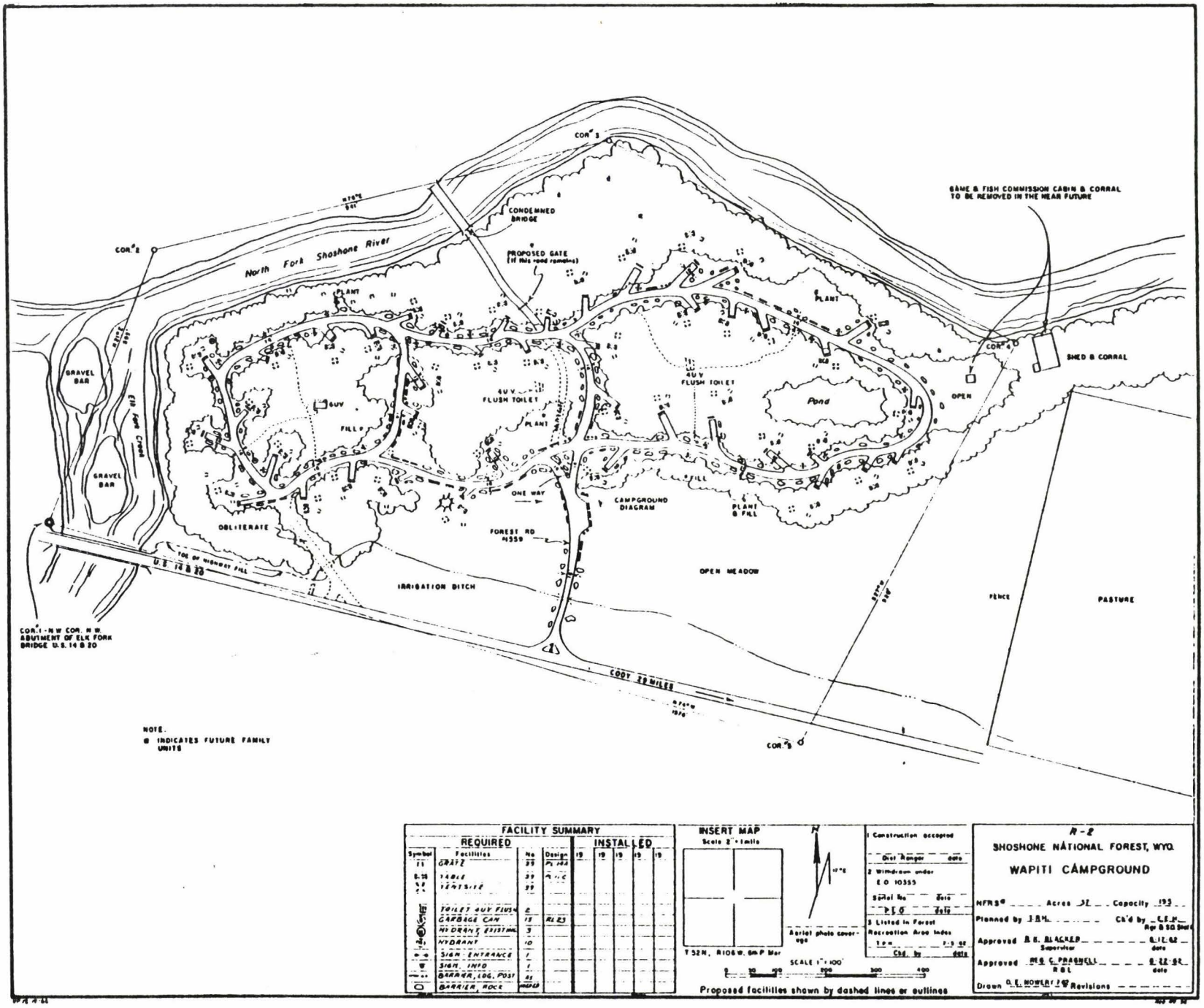
1 Classified for recreation use under Authority of Regulation U-3 (R) R & L date

2 Withdrawn from mineral entry as shown on the land status map under EO 10355 F S date

3 Listed in Forest Recreation Area Index. date

R-2
Shoshone National Forest, Wyoming
LAYOUT PLAN FOR
BIG-GAME TRAILER CAMP

Area 2.2 Acres. Capacity 10?
Planned by J B Scott Ckd by
Approved [illegible] 11-19-57
S. Supervisor Date
Approved Reg C. Pregnall 11/19/57
R & L




**FACILITY SUMMARY**

| Symbol | Facilities | REQUIRED No | REQUIRED Design | INSTALLED 19 | 19 | 19 | 19 | 19 |
|---|---|---|---|---|---|---|---|---|
| TS | GRATE | 39 | PL.RR | | | | | |
| T-39 | TABLE | 39 | PL.RR | | | | | |
| ST | TENT SITE | 39 | | | | | | |
| | TOILET 4UV FLUSH | 4 | | | | | | |
| | GARBAGE CAN | 19 | PL.RR | | | | | |
| | HYDRANT EXISTING | 3 | | | | | | |
| | HYDRANT | 10 | | | | | | |
| | SIGN - ENTRANCE | 1 | | | | | | |
| | SIGN - INFO | 1 | | | | | | |
| | BARRIER, LOG, POST | 81 | | | | | | |
| | BARRIER, ROCK | PAVED | | | | | | |

**INSERT MAP**
Scale 2" = 1 mile

T 52 N., R 106 W., 6th P. Mer.

Aerial photo coverage

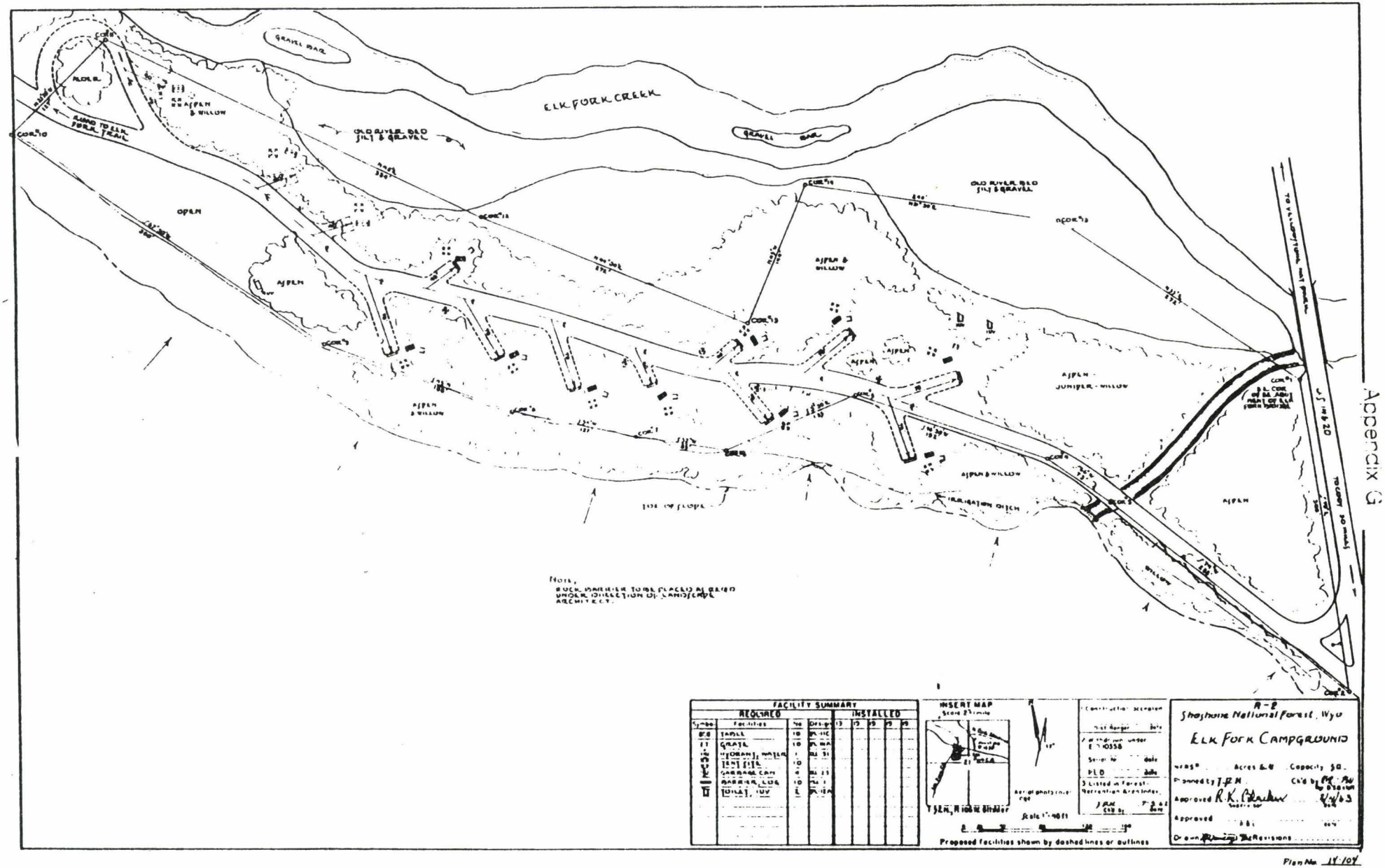
SCALE 1" = 100'

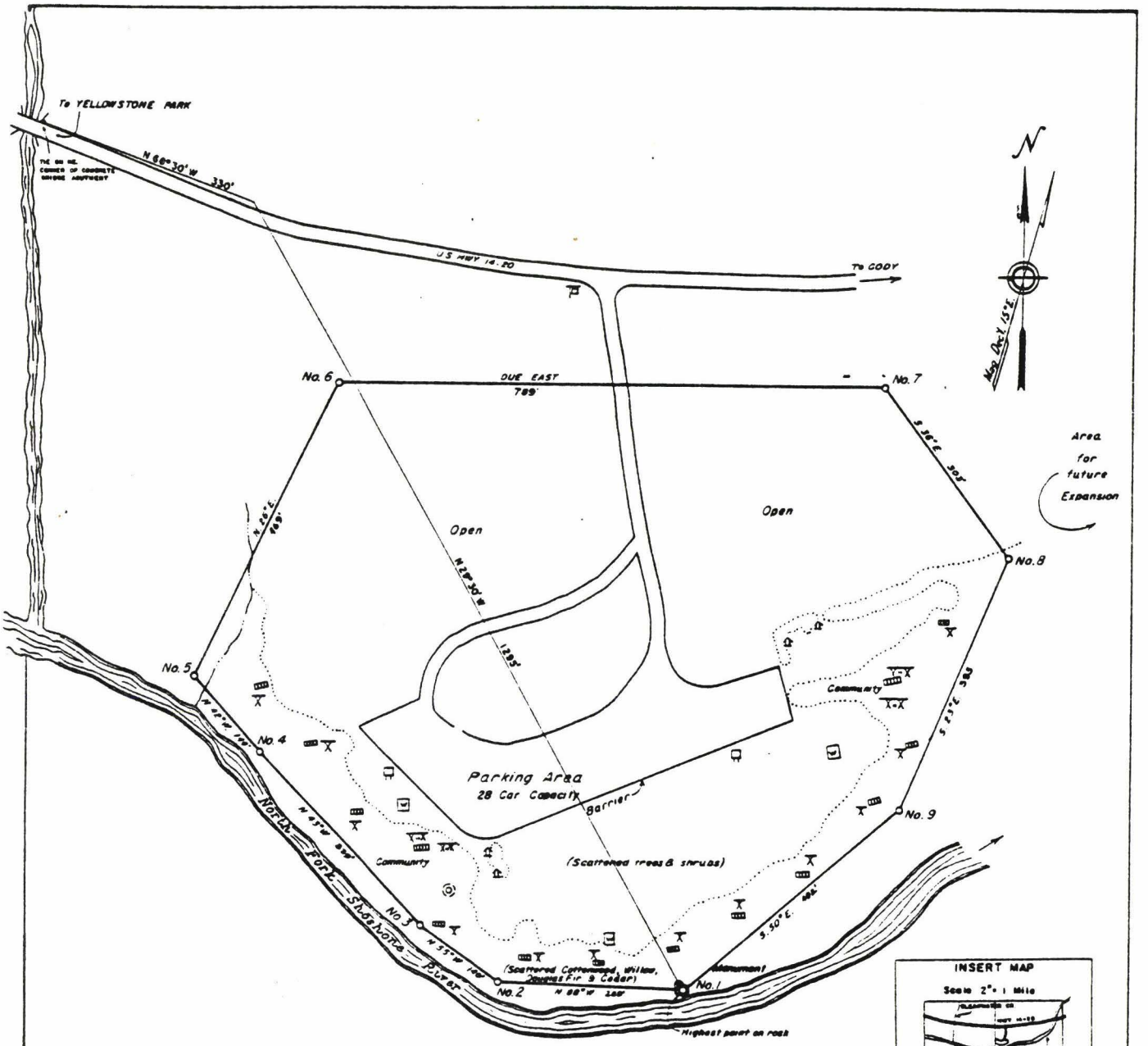
Proposed facilities shown by dashed lines or outlines

1 Construction accepted
Dist. Ranger date
2 Withdrawn under E.O. 10355
Serial No. Date
P.L.O. Date
3 Listed in Forest Recreation Area Index
Init. P-3 65
Chd. by date

R-2
SHOSHONE NATIONAL FOREST, WYO.
WAPITI CAMPGROUND

NFRS# ____ Acres 32 Capacity 192
Planned by J.B.M. Ch'd by C.E.H. Rpr & SO Sheet
Approved R.E. BLACKER Supervisor 8.15.68 date
Approved M.G. C. PRAGNELL R.O.I. 8.22.68 date
Drawn O.E. HOWLEY Revisions


ELK FORK CREEK
GRAVEL BAR
OLD RIVER BED SILT & GRAVEL
ROAD TO ELK FORK TRAIL
ASPEN & WILLOW
OPEN
ASPEN
ASPEN - JUNIPER - WILLOW
IRRIGATION DITCH
TO YELLOWSTONE NAT. PARK
U.S. HWY 20
TOWN OF ISLETA
Note,
ROCK, PARKING TABLE PLACED AS DIRECTED UNDER SUPERVISION OF LANDSCAPE ARCHITECT.
FACILITY SUMMARY
REQUIRED
INSTALLED
INSERT MAP
T 52 N., R 108 W.
Proposed facilities shown by dashed lines or outlines
R-2
Shoshone National Forest, Wyo
ELK FORK CAMPGROUND
Approved R. K. Peterson
Plan No. 18-104




| Facilities Required | | | | Facilities Installed | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Symbol | Facility | No. | Approved Design | 19 | 19 | 19 | 19 | 19 | |
| | Grate | 12 | RL-27 | | | | | | |
| | Community Grate | 2 | RL-29 | | | | | | |
| | Table | 12 | RL-48 | | | | | | |
| | Toilet | 4 | RL-52 | | | | | | |
| | Sign - Entrance | 1 | RL-40 | | | | | | |
| | Bulletin Board | 2 | RL-20 | | | | | | |
| | Garbage Can | 20 | RL-23 | | | | | | |
| | Bonfire Circle | 1 | RL-10 | | | | | | |
| | Water Wells | 3 | | | | | | | |
| | Table (Community) 16 P. | 4 | RL-49 | | | | | | |
| | | | | | | | | | |

INSERT MAP
Scale 2" = 1 Mile
(Unsurveyed)
T. 52 N. R. 103 W. 6th PM.

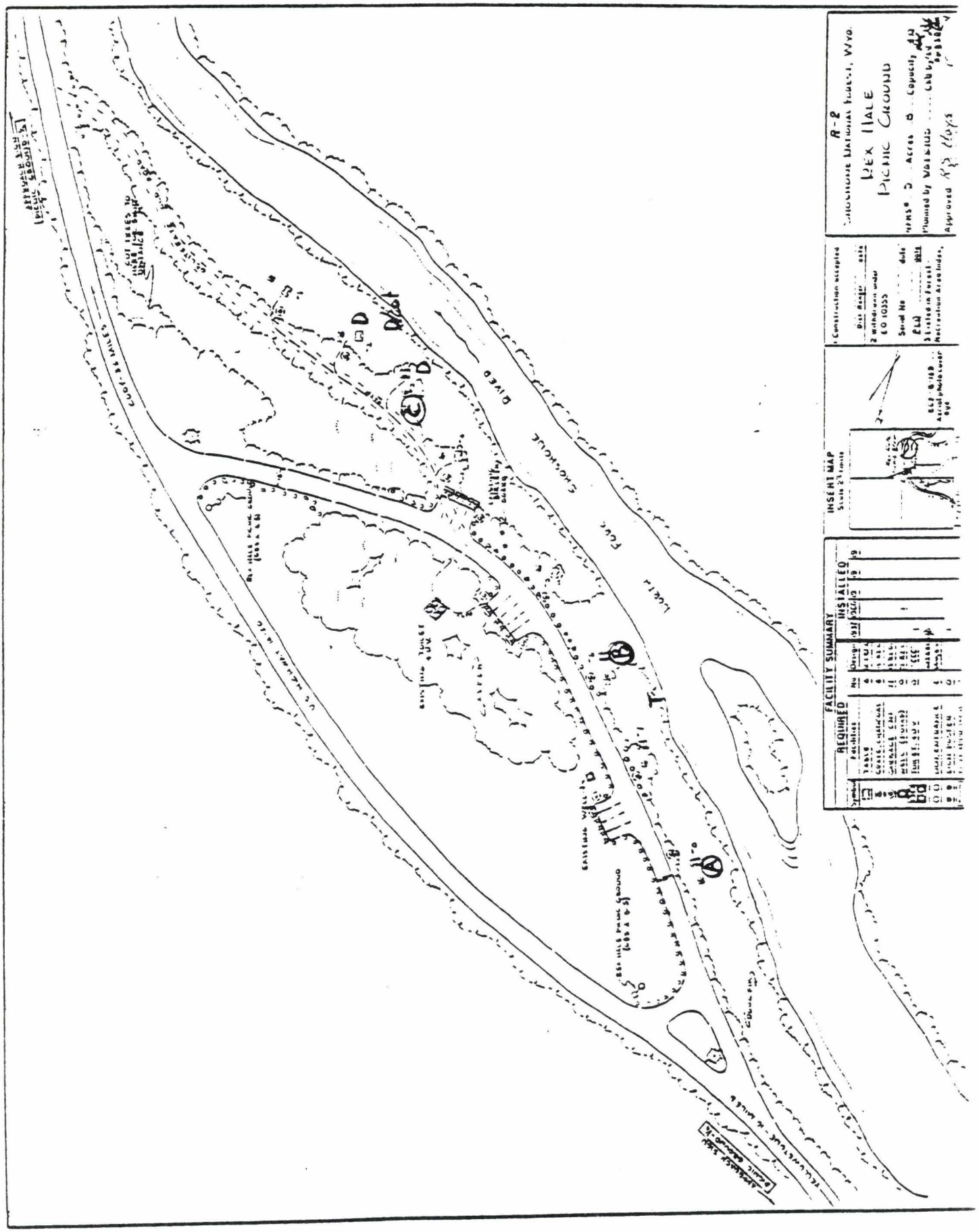
R-2
SHOSHONE NATIONAL FOREST
WYOMING

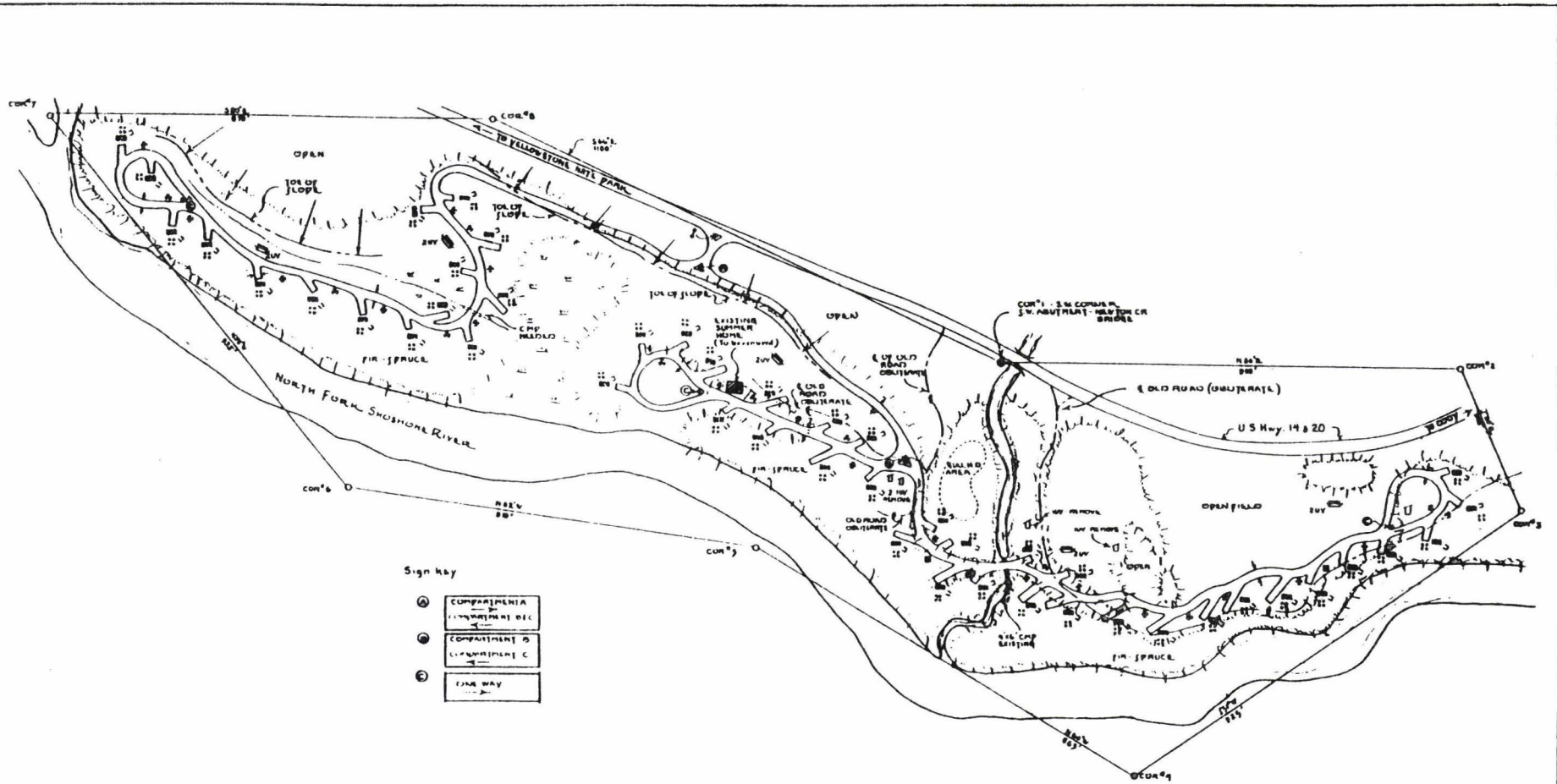
# CLEARWATER PICNIC AREA

Capacity - 132 Area -
Scale: 1 in = 100 ft

Plan by MacMackin 8-31-55
Checked by [illegible]
Approved K.O. Wilson Supervisor 10/12/55 Date
Approved [illegible] Regional Forester 10/14/55 Date

Appendix I






FACILITY SUMMARY

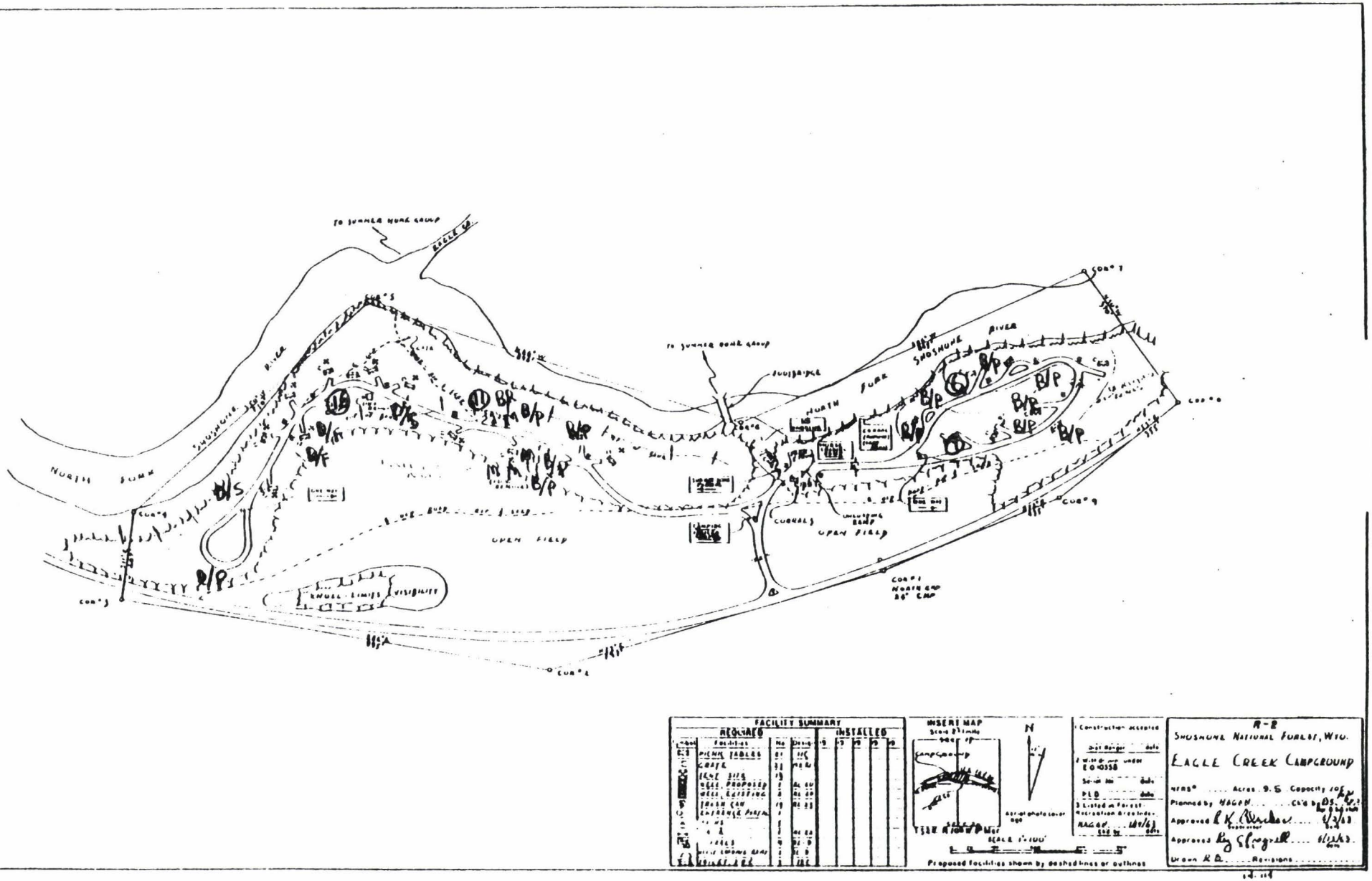
| Symbol | Facilities | No | Design | Required | Installed |
|---|---|---|---|---|---|
| | TABLE | 46 | PA RC | | |
| FT | GRATE | 46 | PA RA | A | |
| | FIRE SITE | 46 | | | |
| | GARBAGE CAN | 30 | PA RB | | |
| | WOODHAUL | 10 | PA RC | | |
| | TOILET BLDG | 3 | PA 12C | | |
| | SIGN | 5 | | | |
| | SIGN ENTRANCE | 1 | | | |
| | WELL-EXISTING | 2 | PA 88 | | |

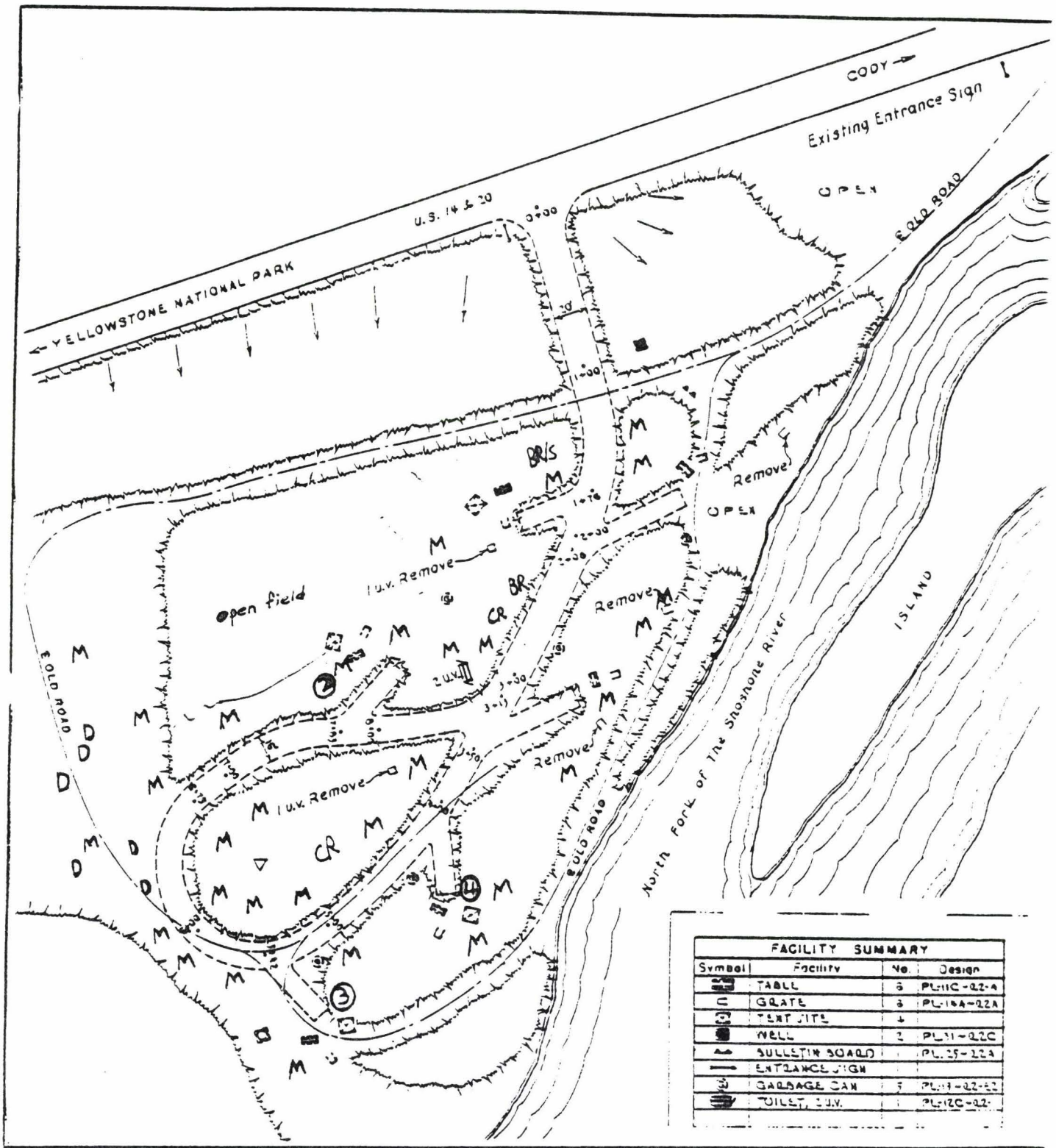
INSERT MAP
Scale 2"=1 mile
T 52 N., R 108 E., 6th P.M.
Aerial photo cover
Scale 1"=1000'
Proposed facilities shown by dashed lines or outlines

Construction accepted
Date Ranger Date
Permit drawn under
Serial No. Date
P.L.O. Date
Listed in Forest Recreation Arch Index
Date Entered by

R-2
Shoshone National Forest, Wyo.
NEWTON CREEK CAMPGROUND
WFMS# Acres 35.8 Capacity 238
Planned by R.W.H. Ck'd by R.K.A.
Approved R.K. Meadow 3-13-63
Approved [illegible] 3/19/63
Drawn D.E.H. Revisions

Plan No. 14-102


TO SUMMER HOME GROUP
EAGLE CR.
SHOSHONE RIVER
NORTH FORK
OPEN FIELD
CONC. 1
CONC. 2
CONC. 3
CONC. 4
CONC. 5
CONC. 6
CONC. 7
CONC. 8
CONC. 9
CONC. 10
CONC. 11
B/P
B/S
B/T
FACILITY SUMMARY
REQUIRED
INSTALLED
INSERT MAP
N
Proposed facilities shown by dashed lines or outlines
R-2
SHOSHONE NATIONAL FOREST, WYO.
EAGLE CREEK CAMPGROUND
Planned by HAGAN
Approved R K Bleecker 4/3/63
Approved By S Gregg 4/24/63
Drawn R.D.
Revisions




| FACILITY SUMMARY | | | |
|---|---|---|---|
| Symbol | Facility | No. | Design |
| | TABLE | 8 | PL-11C-22-A |
| | GRATE | 8 | PL-10A-22A |
| | TENT SITE | 4 | |
| | WELL | 1 | PL-11-22C |
| | BULLETIN BOARD | 1 | PL-25-22A |
| | ENTRANCE SIGN | | |
| | GARBAGE CAN | 5 | PL-1-22-C |
| | TOILET, 2 U.V. | 1 | PL-12C-22- |

LOCATION MAP
Scale 2" = 1 mile

Sec. 12 Twp. 52N R. 109W
6th Prin. Mer.

ORIENTATION

DESIGN CAPACITY
2.4 Development Acres
8 Family units
30 People

Aerial Photo Coverage
Contour Interval ____ Feet

0 20 40 80 120
Scale 1" = 40 Feet

| DESIGN | REVIEW | |
|---|---|---|
| | FOREST | R.O. |
| Recreation HAGAN | | |
| Engineering | | |
| Other | | |

RECOMMENDED FOR APPROVAL
DISTRICT RANGER — FOREST SUPERVISOR

APPROVED
Reg. C. Bennett — Apr 2 16 1964
DATE

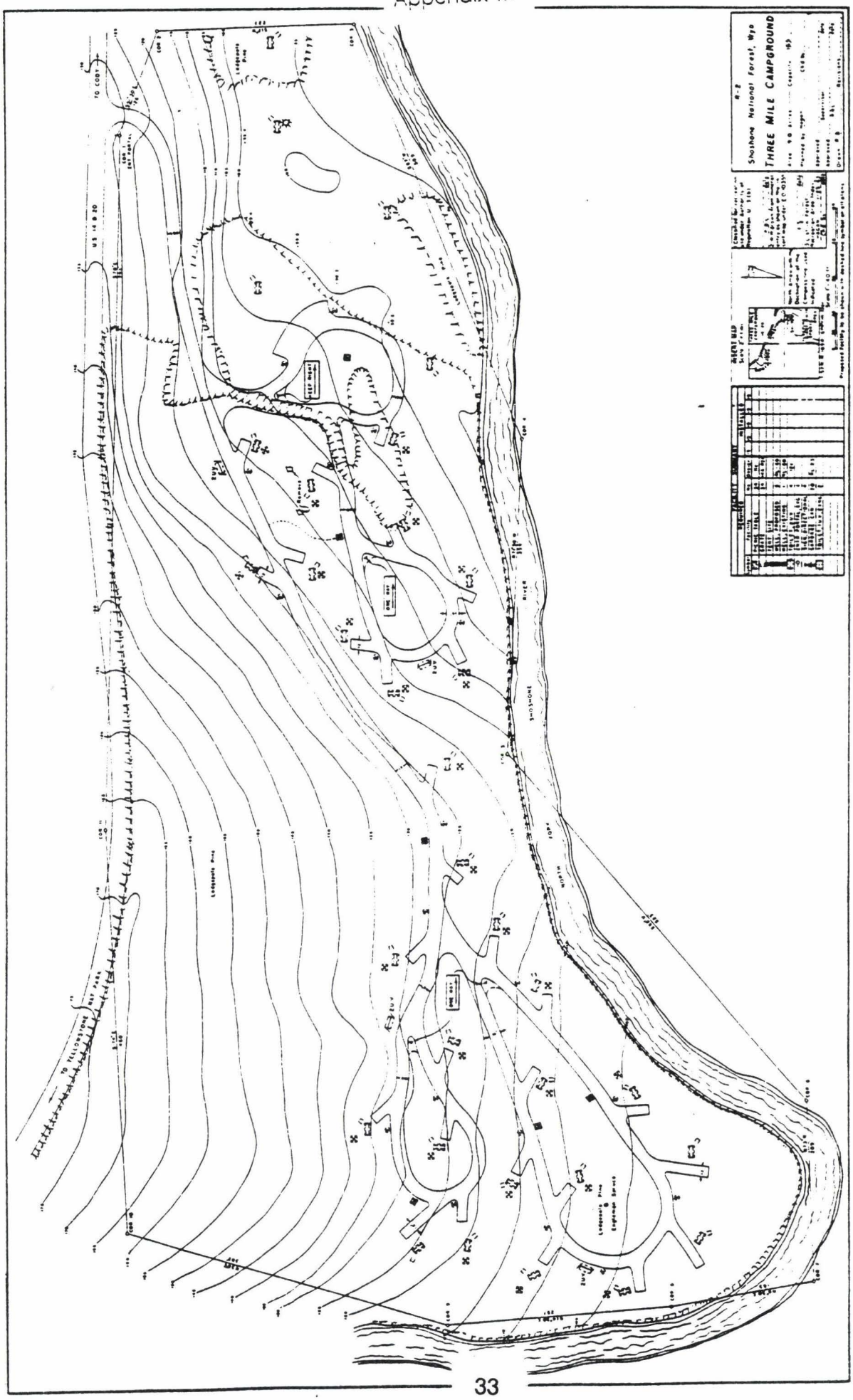
U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Rocky Mountain Region

SHOSHONE
National Forest

SLEEPING GIANT
CAMPGROUND

R2 - 2300-9
6-63

Sheet 1 of 1


Shoshone National Forest, Wyo
THREE MILE CAMPGROUND

## LITERATURE CITED

Angwin, P.A. 1990. Pest conditions and potential hazard trees in Chapman Campground, Chapman Group Camp and Elk Wallow Campground, Sopris Ranger District, White River National Forest, Colorado. USDA Forest Service Biological Evaluation R2-90-2. 38p.

FPM. 1990a. Guidelines for the use of FPM funding for suppression of dwarf mistletoe in recreation areas. USDA For. Serv., Timber, For. Pest, and Coop. For. Mgmt., Letter to Forest Supervisors, File Desig. 3400, July 16, 1990. 7p.

FPM. 1990b. Vegetation management in developed sites. USDA For. Serv., Timber, For. Pest, and Coop. For. Mgmt., Letter to Forest Supervisors, File Desig. 2300/3400, Dec. 3, 1990. 3p.

Hawksworth, F.G. 1977. The 6-class dwarf mistletoe rating system. USDA For. Serv. Rocky Mtn. For. and Range Exp. Sta. Gen. Tech. Rep. 48. 7p.

Hawksworth, F.G. and D.W. Johnson. 1989. Biology and management of dwarf mistletoe in lodgepole pine in the Rocky Mountains. USDA For. Serv., Rocky Mtn. For. and Range Exp. Sta. Gen. Tech. Rep. RM-169. 38p.

Johnson, D.W. 1981. Tree hazards - recognition and reduction in recreation sites. USDA For. Serv., Timber, For. Pest, and Coop. For. Mgmt. Tech Rep. R2-1. 17p.